Econometric Methodology of Assessed Valuation and New Construction Forecasts

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The Office of Economic and Financial Analysis (OEFA) employs econometric models to generate assessed valuation and new construction forecasts. This is of a two-step "error-correction" form, which has the practical benefit that it combines both cyclical and trend information in the same forecasting model. We first estimate a double-log form to get the trend equilibrium relationship and then embed it in a rate-of-change model to capture the cyclical turning points.

Step 1 – Estimation of the Trend Equilibrium Relationship

We will assume there is only one predictive variable X to keep the illustration simple.

$$lnY_t = \alpha_1\, lnX_{1t} + \alpha_2 + u_t$$

Where:

$lnY_t =$ Natural log of assessed value (AV) or new construction (NC)

$lnX_{1t} =$ Natural log of a predictive variable (e.g., construction employment) which have available projections from a forecasting service.

$\alpha_1, \alpha_2 =$ Estimated coefficients

$u_t =$ Deviation of AV or NC from trend equilibrium at time t

We estimate this "cointegrating regression" by a technique called fully-modified least squares. This captures the equilibrium relationship between a set of trending variables.[1] The residual u_t measures the current deviation from equilibrium – if it is positive then AV or NC is above its equilibrium level and will likely move downward until it reaches trend equilibrium. Likewise, if the residual is negative then revenue will likely move upward.

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[1] Phillips and Hansen (1990), "Statistical Inference in Instrumental Variables Regression with I(1) Processes," *Review of Economic Studies,* 57, 99-125.

Step 2 – Estimation of the Error-Correction Model

The trend equilibrium relationship is important for out-year forecasts. However, that alone can miss cyclical turning points in the near-year forecasts. An "error-correction" model incorporates both trend and cycle information. We use rates of change to capture the cyclical turning points while using the residual estimated in Step 1 as the long run trend component:

$$\Delta lnY_t = \beta_1 \Delta lnX_{1t-1} + \beta_2 \Delta lnY_{t-1} + \beta_3 + \gamma u_{t-1} + \varepsilon_t$$

Where:

$\Delta lnY_t, \Delta lnY_{t-1}, \Delta lnX_{1t-1} =$ Variables from Step 1 in rate-of-change form

$u_{t-1} = lnY_{t-1} - \alpha_1 lnX_{1t-1} - \alpha_2 =$ Deviation from trend equilibrium last year

$\beta_1, \beta_2, \beta_3, \gamma =$ Estimated coefficients.

The coefficient γ governs the speed of adjustment back to equilibrium; it is expected to be between -1 and 0. If lnY_t is above its equilibrium value, then u is positive, and the negative γ will make the rate of change negative; so it will pull down or <u>correct</u> lnY_t back toward trend equilibrium. Likewise, if lnY_t is below its equilibrium value, then u is negative, and the negative γ will make the rate of change positive; so it will bump up or <u>correct</u> lnY_t back toward trend equilibrium.

Forecasting with the Error-Correction Model

Dynamic or "chain" forecasting log-levels from the error-correction model is straightforward. Let T be the end of the historical data, then the forecast k periods forward is:

$$lnY_{T+k} = lnY_{T+k-1} + \beta_1 \Delta lnX_{1T+k-1} + \beta_2 \Delta lnY_{T+k-1} + \beta_3 + \gamma[\, lnY_{T+k-1} - \alpha_1 lnX_{1T+k-1} - \alpha_2]$$

As long as we have forecasts for the predictive variable X, then Y can be dynamically updated into a chain of forecasts.

Variable Selection, Consensus Forecasting, and a 65% Confidence Level

The forecasting framework just illustrated depends on having forecasts of the predictive variables X. We obtain them from forecasting services. There are many forecasting services available, each with its supporters and detractors. We have employed several to use the principle of diversification: from several models we can get a kind of consensus forecast that combines the thinking of all of them while not being overly

sensitive to any one. In addition, the spread of the forecasts across the models is a measure of how uncertain is the forecasters' opinion.

We fit five error-correction models each for AV and NC, each of the models using different sets of projections from forecasting services. From Global Insight we construct three sets of forecasts based on their baseline, optimistic, and pessimistic projections of national economic indicators. From the Washington State Economic and Revenue Forecast Council (ERFC) we generate forecasts based on their projections of Washington state economic indicators. From the Puget Sound Economic Forecaster (PSEF) we generate forecasts based on their projections of Puget Sound and King County economic indicators.

Variable selection for the models follows a simple methodology. We start with a short list of 5-10 candidate variables. The candidate list is pared down to 1-3 variables using the criteria of forecast mean absolute deviation, the Schwarz criterion, the requirement that $-1 < \gamma < 0$, and that the signs in the cointegrating regression agree with theory. [2] See the Assumptions and Methodology web page for the variables selected.

The average of the five sets of forecasts represents a median consensus forecast. The Forecast Council requires a more conservative forecast, one set at a 65% confidence, meaning there is a 65% probability that actual revenues will exceed forecasted. For each out-year we have n = 5 forecasts that form a distribution, which is assumed to be a Student's t-distribution with n-1 = 4 degrees of freedom. The mean of that distribution is the expected value, median or 50% confidence level forecast. The 0.35 percentile of the distribution produces the 65% confidence forecast.

Chart 1 illustrates how this works in practice for new construction. We apply a similar calculation to produce the 65% confidence level forecast of assessed valuation. An expected value/median/ 50% confidence level forecast would be slightly higher than the 65% confidence forecast for each year.

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[2] Schwarz, G. (1978), "Estimating the Dimension of a Model," *Annals of Statistics,* 6, 461-464

Chart 1

65% Confidence Level Forecast of New Construction